

Context-aware Recommender Systems for Learning: a Survey and Future Challenges

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Abstract—Recommender systems have been researched extensively by the Technology Enhanced Learning (TEL) community in the last decade. By identifying suitable resources from a potentially overwhelming variety of choices, such systems offer a promising approach to facilitate both learning and teaching tasks. As learning is taking place in extremely diverse and rich environments, the incorporation of contextual information about the user in the recommendation process has attracted major interest. Such contextualization is researched as a paradigm for building intelligent systems that can better predict and anticipate the needs of users, and act more efficiently in response to their behavior. In this paper, we try to assess the degree to which current work in TEL recommender systems has achieved this, as well as outline areas in which further work is needed. First, we present a context framework that identifies relevant context dimensions for TEL applications. Then, we present an analysis of existing TEL recommender systems along these dimensions. Finally, based on our survey results, we outline topics on which further research is needed.

Index Terms—Adaptive and Intelligent Educational Systems, Personalized E-Learning, System Applications and Experience.

1 INTRODUCTION

Recommender systems have been researched and deployed extensively over the last decade in various application areas, including e-commerce and e-health. Several recommendation algorithms, such as content-based filtering [98], collaborative filtering [57], knowledge-based filtering [22] and their hybridizations [24], are widely discussed in the literature and in several surveys of the state-of-the-art [23][3].

Also in the Technology Enhanced Learning (TEL) domain, the deployment of recommender systems has attracted increased interest during the past years. This interest is reflected in the growth of dedicated workshops and special issues on Social Information Retrieval [137][43][44] and Recommender Systems [84] for TEL and is well justified. Whereas Google and other search

engines are bound to have a higher recall as they index most of what is available on the Web, their precision for learning is low [40]. It is difficult to express a specific learning requirement through keywords. For example, search engines do a poor job when a learner needs content about “relativity theory”, oriented to high school level, with a duration of about 30 minutes. Finding relevant resources can be even more difficult when requirements are not always fully known by the learner, such as her level of competence or adequate technical format for her situation.

Recommender systems for learning try to address these challenges - i.e. they attempt to filter content for different learning settings. A recent survey of recommender systems in TEL has been elaborated by Manouselis et al. [85]. The authors presented an extensive overview of TEL recommender systems. In addition, evaluation perspectives on current research in this area and future challenges with respect to the evaluation of TEL recommenders were discussed.

The notion of context started to attract significant attention in this line of research, as indicated by contributions to a recent special issue on context-aware recommender systems [135]. Among others, advancements of network and mobile services, the growing tool and device landscape and the pervasive computing vision provide many new opportunities for the TEL domain to adjust itself to this landscape appropriately [125]. A new set of recommender systems for learning has been developed in recent years to demonstrate the potential of contextual recommendation.

From an operational perspective, context is often defined as an aggregate of various categories that describe the setting in which a recommender is deployed, such as the location, current activity and available time of

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